Maximising value for money in rural road investments

The cost of rural road construction in India could be brought down by 20 percent through effective use of local materials and innovative technologies

The Ministry of Rural Development (MORD) is implementing Pradhan Mantri Gram Sadak Yojna (PMGSY) to provide all-weather road access to all the villages above 500 inhabitants (250 in special areas), involving an expenditure of more than US$60 billion. The World Bank is supporting PMGSY through the US$1.4 billion PMGSY Rural Roads Project. Many states are also implementing similar programs to provide all-weather road access to smaller villages not covered under PMGSY.

One of the areas of concern is the affordability of the convention construction specifications used for low-traffic rural roads, generally carrying less than 100 vehicles per day. The typical specifications used are a 15-20 cm granular sub-base, a minimum of two layers of water-bound macadam (WBM) with 7.5 cm each, and a premix bituminous carpet of 20 mm thickness. These specifications are used very widely without much regard to the traffic levels, soil type and local materials available. There are often problems for using WBM in areas where the required quantities for water and local labor are not easily available.

This type of construction becomes very costly in areas where the hard stone is to be transported from long distances. It is believed that the same level of sophistication, as for highly trafficked rural roads carrying 200 or more vehicles is not required for the low trafficked rural roads connecting smaller villages. Significant savings could be put into effect for these roads by using locally available granular materials, soils, quarry wastes and other marginal materials.

With a view to explore alternatives to save in road construction, the World Bank supported studies in the states of Rajasthan and Bihar in May 2014 to review current practices in pavement design including pavement composition, availability and suitability of local material for road construction and use of industry waste.

In the state of Bihar, crushed rock is transported covering distance as far as 300 km to be used in the construction of rural roads resulting in long hauls, increased freight costs, impact on environment, and excessive loading of the national and state highway network. In the state of Rajasthan, crushed rock is available at relatively short distances; however, it is expensive due to its use in building industry. Local waste materials such as copper slag, marble waste and *Kotah* stone are also available for use as alternate materials for the construction of rural roads.

The current practices of pavement design specify a pavement of 300-325 mm using granular sub-base and WBM type of base, irrespective of sub-grade CBR and martial availability. Sub-grade strength is not widely tested or designed, and the standard specifications are: 15 cm granular sub base + 15 cm water bound macadam in two layers + prime, premix and seal. Use of local material or the industry waste is rather limited.

Initial observations indicate that the pavement thickness can be reduced to 20 cm or below, resulting in significant cost savings. This can further be made cost effective by improving the properties of local soil (clay, silt, sand) by stabilisation techniques and using local material such as *kankar* or *murrum* from nearby borrow pits. The waste material from industry such as *Kotah* stone, marble waste and copper slag can effectively be used to replace crusted rock in the sub-base layer.

Effective use of machinery in stabilisation and compaction can further reduce costs and enhance the life of the pavements. Therefore, there is a need to further engage in field trials utilising these materials, using innovative technologies such as cold mixes, foam bitumen, emulsions, thin concrete pavements and Otta seal.

Local materials were identified and field trials have been recommended to use the local material in Rajasthan (*Kotah* stone, Jarofix, marble dust and marble waste, *kankar*, *kolac*, copper slag) and Bihar (fly ash, river sand, *moorum* (local granular material in natural form)), giving due consideration to economic benefits.

Recommendations included: improvement to local soils by mechanical or chemical stabilisation, use local material/industry waste with low leads (up to 10 km) for use as sub base/base material of 75 cm to 150 cm in thickness, as required based on traffic volume.

Trail specifications for very low volume roads in Rajasthan are presented in the table below:

General condition (subgrade type, local material, rainfall to 600mm (in Rajasthan)	**Traffic :<50 vpd (2 heavy vehicles) Population served: <250**	**Traffic: 50-100 vpd (4-6HV) Population served: 251-500**
Clay	• Subgrade compacted to OMC (as practical) • 150mm stabilized clay with 4% cement/marble waste (if locally available)/or use 150 mm compacted local waste • Emulsion for prime and surfacing with sand as required	• Subgrade compacted to OMC (as practical) • 150mm stabilized clay with 4% cement/marble waste(if locally available)/or use 150 mm compacted local waste • 50mm wet-mix macadam (WMM) • Emulsion for prime and surfacing with sand / Otta seal/surface dressing as required
Silty	• Subgrade compacted to OMC (as practical) • 150mm stabilised silt (with 4% or less cement)/ 150mm compacted local/waste material • Emulsion for prime and surfacing with sand as required	• Subgrade compacted to OMC (as practical) • 150mm stabilised silt (with 4% or less cement)/ 150mm compacted *kankar* or other local/waste • 50mm WMM • Emulsion for prime and surfacing with sand / Otta seal/surface dressing as required

Sandy	• Subgrade compacted • 150mm stabilised sand/GSB (or 150 mm quarry waste/other local /waste material) • Emulsion for prime and surfacing with sand	• Subgrade compacted • 150mm GSB (Or 150 mm quarry waste/ other local /waste material) • 50mm WMM • Emulsion for prime and surfacing with sand / Otta seal/surface dressing as required
Partially hilly, hilly, rocky	• Subgrade compacted to OMC (if practical, as area is hilly/rocky) • 100mm stabilized sand/GSB (or 100 mm Quarry waste/other local /waste material) • Emulsion for prime and surfacing with sand as required	• Subgrade compacted to OMC (if practical as area is hilly/rocky) • 100mm stabilized sand/GSB(Or 100 mm quarry waste/other local /waste material) • 50mm WMM • Emulsion for prime and surfacing with sand / Otta seal/surface dressing as required

Technologies to be trialled in Bihar will include:

- Cold mix
- Soil stabilisation (clay with four percent cement)
- Roller compacted concrete pavement (RCCP)
- Fly ash (replace cement with 30-40 percent fly ash RCCP)
- Cell-filled concrete
- Cold mix surfacing (emulsion for premix, seal)
- Mix with clay soil
- *Murrum*
- Stabilise with cement/sand/stone dust
- Single-layer 150 mm wet mix macadam + cold mix (instead 300 mm conventional)
- Fly ash 30 percent with 70 percent clay